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(54) **ON-BOARD BRAKE SYSTEM DIAGNOSTIC AND REPORTING SYSTEM**

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(51) **Int. Cl.**

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B60W 50/02	(2012.01)
B60T 8/88	(2006.01)
B60L 3/12	(2006.01)
B60W 10/20	(2006.01)
B60W 50/04	(2006.01)
B60T 17/22	(2006.01)
B60T 13/66	(2006.01)

(52) **U.S. Cl.**

CPC ***B61L 15/0081*** (2013.01); ***B60L 3/12*** (2013.01); ***B60T 8/885*** (2013.01); ***B60T 13/665*** (2013.01); ***B60T 17/22*** (2013.01); ***B60T 17/228*** (2013.01); ***B60W 10/18*** (2013.01); ***B60W 10/20*** (2013.01); ***B60W 50/0205*** (2013.01); ***B60W 50/04*** (2013.01)

(58) **Field of Classification Search**

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USPC 701/19, 29.1, 29.4, 31.4, 31.8, 33.4, 701/34.4

See application file for complete search history.

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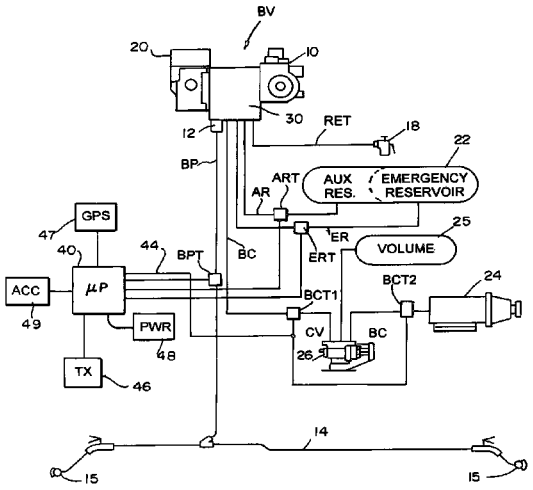
(57) **ABSTRACT**

A brake valve diagnostic and reporting system for a pneumatic only brake valve on a rail car which includes a brake pipe transducer for measuring brake pipe pressure; and a brake cylinder transducer for measuring brake cylinder pressure. A processor receives measurements from the transducers, compares the measurements against stored brake performance profiles, determines brake status from the comparison and prepares an event report for preselected brake statuses. A wireless transmitter connected to the processor transmits the report. An energy storage device powers the processor and transmitter.

8 Claims, 2 Drawing Sheets



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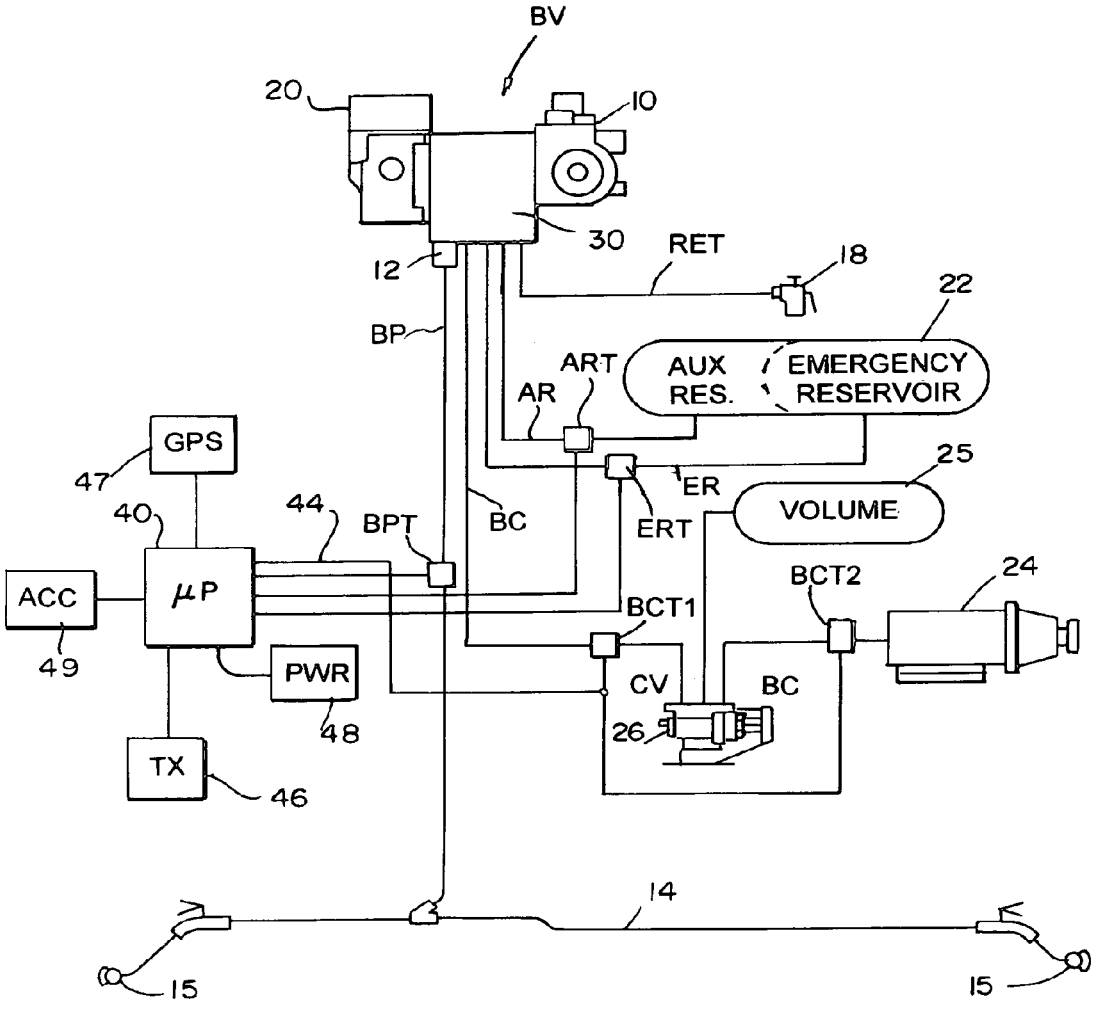
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FIG. 1

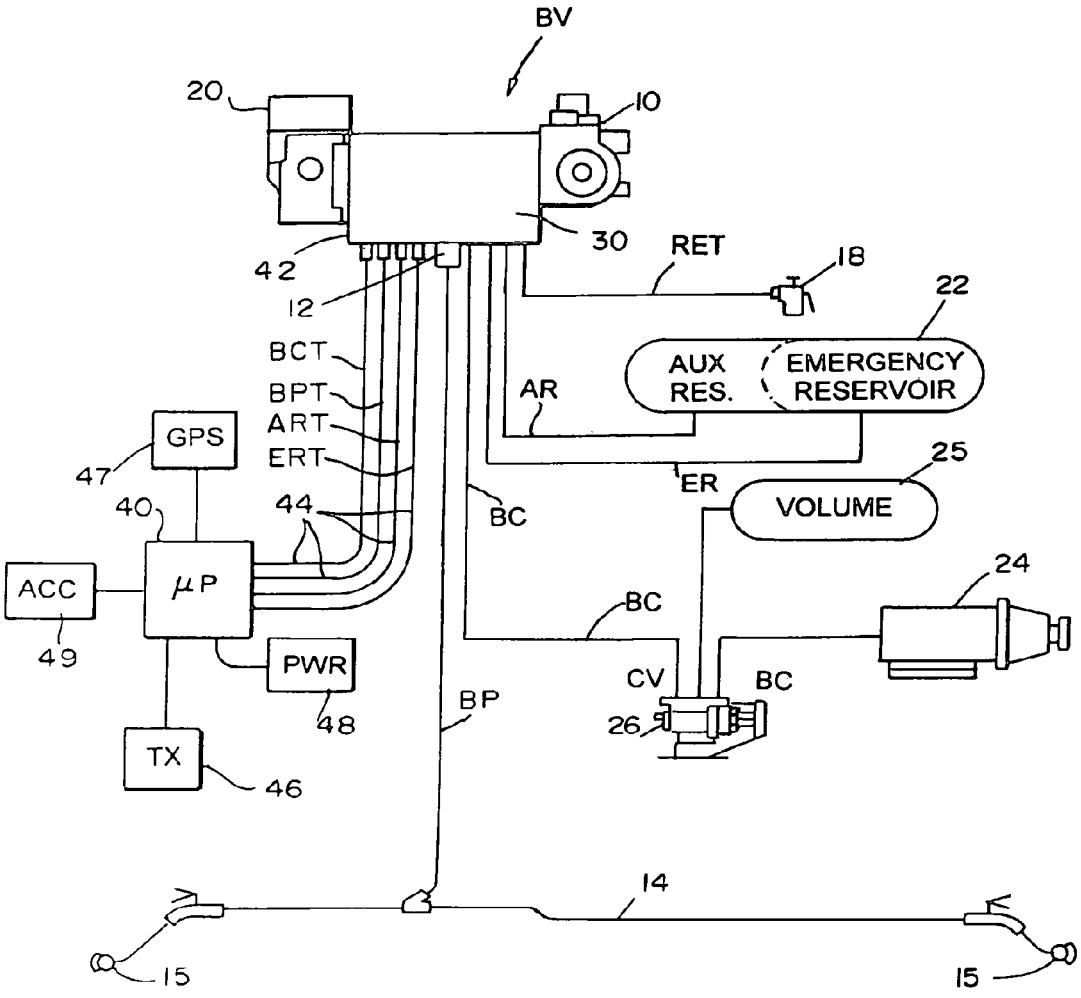
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FIG. 2

ON-BOARD BRAKE SYSTEM DIAGNOSTIC AND REPORTING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 11/356,967, filed on Feb. 21, 2006, which claimed priority to U.S. Provisional Application No. 60/688,722, filed on Jun. 9, 2005.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to railroad brake monitoring systems, and more specifically to a monitoring and diagnostic system for a pneumatic only brakes on a rail car.

2. Description of the Related Art

Portable single car testers are known. These are used for cars that were not connected to a train. They put the brake valve and the brake system on the car through various tests by manipulating the valves and making various measurements at various points including the brake pipe pressure and brakes cylinder pressure. Typical examples are shown in U.S. Pat. Nos. 5,808,909, 6,094,997 and 6,269,682. An interface for connection to an electronically controlled pneumatic (ECP) brake system is described in the U.S. Pat. No. 5,808,909 patent.

Electric pneumatic brake systems are either stand alone electronic valves which are connected by wire or radio to the locomotive and receives braking signals electrically to control the brakes by controlling the air to and from the brake cylinder. The ECP system may also include an overlay or a pilot adaptor wherein a standard pneumatic valve is manipulated by the solenoids to perform its normal function while the brake pipe is still charged. Typical adaptor systems are shown by U.S. Pat. Nos. 5,390,988 and 5,676,431

U.S. Pat. No. 2,993,199 is a train inspection apparatus which determines whether a light or a full brake has been applied or whether the brakes have been released. This is an electrical polling system for a wired train. U.S. Pat. No. 2,993,199 and U.S. Pat. No. 5,390,988 monitor the brake cylinder pressure which is reported to the head end for the locomotive engineer. U.S. Pat. No. 5,676,431 includes a transducer for brake pipe, brake cylinder, and auxiliary reservoir and uses information to initiate braking electric pneumatically as well as addressing stuck brakes.

U.S. Pat. No. 5,862,048 is a microprocessor electric-pneumatic locomotive brake control and train monitoring system. This is an electric pneumatic brake system on the car with sensors whose valves are transmitted back to the head end processor in the locomotive. The braking diagnostic functions include stuck brake identification, release while the train is in motion, collective gradual release of train brakes, out of tolerance brake cylinder pressures, accelerated direct release brakes, the source of emergencies, wheel off detection, wheel identification by number and location, status of every train vehicle, box detection, and sliding flat wheels. This information and sensors are part of the EPC brake control system.

U.S. Pat. No. 6,175,784 is a remotely operated rail car status monitor and control system. The hand brake status and release monitor determines and reports the status of the hand brake and an operator releases the hand brake. The monitor also includes a perality of sensors which includes a slide wheel sensor and train handling sensor. The train handling sensor identifies impact. The car monitoring device responds to a wakeup signal from a hand held data terminal.

U.S. Pat. No. 6,837,550 is a brake system diagnostic using a hand-held radio device. The car brake system includes a radio based feed valve which includes a sensor to measure different pressures in the brake system. The hand-held device retrieves brake system data and information from the radio based feed valve and interprets the retrieved data and information. Maintenance is performed based on the interpretation of the data and information.

BRIEF SUMMARY OF THE INVENTION

A brake system diagnostic and reporting system for a pneumatic only brake valve on a rail car according to the present disclosure includes a brake pipe transducer for measuring brake pipe pressure; and a brake cylinder transducer for measuring brake cylinder pressure. A processor receives measurements from the transducers, compares the measurements against stored brake performance profiles, determines brake status from the comparison and prepares an event report for preselected brake statuses. A wireless transmitter connected to the processor transmits the report. An energy storage device powers the processor and transmitter.

The system may include a geographic location system for determining the location of the rail car connected to the processor; and the processor provides time and location with the event report. The location system may be a global positioning system which provides location and speed and the processor provides speed with the event report. The system may include an accelerometer connected to the processor and the processor provides measurements from the accelerometer with the event report.

The processor may determine at least two of the following brake statuses: good; degradation requiring notice at maintenance; degradation requiring notice at destination; and failure. The processor may determine one or more of the following faults: brake valve failure; slow to apply; slow to release; and failure to release. The processor stores a moving window of measurements from the transducers and provides at least a portion of the window before the event with the event report.

The brake pipe transducer is connected to one of the following: the brake pipe and a brake pipe test port on the brake valve; and wherein the brake cylinder transducer is connected to one of the following: the brake cylinder, a brake cylinder output port of the brake valve, and a brake cylinder test port on the brake valve. If the car includes an empty/load device connecting the brake valve to the brake cylinder, the brake cylinder transducer may also be connected to a brake cylinder output port of the empty/load device.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING(S)

The present invention will be more fully understood and appreciated by reading the following Detailed Description in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram of a pneumatic only brake system of a rail car with the brake valve diagnostic and reporting system according the present disclosure.

FIG. **2** is a block diagram of a pneumatic only brake system of a rail car having test ports with the brake valve diagnostic and reporting system according the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a pneumatic only rail car. The car is part of a train which includes a brake pipe **14** extending through the train and coupled together by couplers or glad-hands **15**. It also includes a standard pneumatic brake valve BV having a service portion **10** and an emergency portion **20** connected to a pipe bracket **30**. The brake pipe **14** is connected through a cut-off cock **12** to port BP of the pipe bracket **30**. A retainer port RT is connected to retainer valve **18**. A reservoir **22** is shown as a combined reservoir having an emergency and an auxiliary section connected to ports ER and AR, respectively. Port BC of the pipe bracket **30** is connected to port CV of an empty/load device **26** having its own reservoir **25**. The output signal BC of the empty/load device **26** is connected to the brake cylinders **24**.

The brake valve and reporting diagnostics system includes a microprocessor **40** connected by wires **44** to a brake pipe transducer (BPT), a brake cylinder transducer (BCT), an auxiliary reservoir transducer (ART), and an emergency reservoir transducer (ERT). The system also includes a transmitter **46** and a power source **48**.

The graphic representation shows the transducers being connected in the piping of the pneumatic brake system. The brake cylinder transducers BCT**1** and BCT**2** are connected on the input and output of the empty/load device **26**. Either one or both of the transducers may be used. This also allows monitoring the operation of the empty load device **26**. Either or both of the reservoir transducers ART and ERT may be used or deleted from the system. The reservoir transducers provide another variable in monitoring and diagnostics of the brake valve (BV).

If the brake cylinder **24** includes test ports as described in U.S. Pat. No. 5,869,715, the brake cylinder transducer BCT may be connected to that port and not through the piping leading into the brake cylinder **24**. Similarly if the empty/load device has a brake cylinder test port as described in U.S. Pat. No. 6,206,483 the transducer may be provided at that test port instead of in the pipe.

A geographic location system, for example GPS, **47** connected to the microprocessor **40** which determines location of the rail car and provides time and location information or time stamp. This may also include the speed information. The microprocessor **40** correlates this information with the data collected from the pressure transducers. The system may also include an accelerometer **49** connected to the microprocessor **40** to determine ride quality.

FIG. **2** is similar to FIG. **1** except that it shows the brake valve (BV) including an access plate **42**, providing access or test ports to the brake cylinder (BC), the brake pipe (BP), the auxiliary reservoir (AR), and the emergency reservoir (ER). Appropriate transducers BCT, BPT, ART, and ERT may be connected to these test ports. Example of such access plate is shown in U.S. Pat. No. 5,451,099. Similarly, plate **42** may be the adaptor plate used in an electro-pneumatic brake control valve illustrated in U.S. Pat. No. 6,457,782. Each of the patents discussed above are incorporated herein by reference to the extent required for further explanation of the details. As a further alternative the plate **42** may have the transducers therein or thereon and provided as a single unit. Wires **44** connect the transducers to the microprocessor **40**.

It should be noted where the railcar brake system does not include an empty load valve **26**, the output BC of the pipe bracket **30** is connected directly to the brake cylinder **24** in that case only a single brake cylinder transducer BCT would be required.

The processor **40** receives transducer signals on lines **44** from the transducers and compares the inputs against an established performance profile or formula. The processor is capable of determining both acceptable and out of tolerance brake valve responses to a range of brake pipe inputs which is defined as a "fault" such as:

Brake valve failure
Stuck or dragging brake
Slow to apply brake
Slow to release brake
Slow reservoir charge
Empty/Load valve failure

The following are examples of how the faults are determined, although other methods may be used. In a pneumatic brake system, brake valve (BV) responds to the raising and lowering of brake pipe pressure to release or apply the brake. The amount of brake application is proportional to the dropping pressure of the brake pipe. A rise in the brake pipe pressure causes the brake valve (BV) to release the pressure in the brake cylinder **24**. This is produced by a relay valve which supplies pressure from the reservoirs **22** to the brake cylinder proportional to the brake pipe pressure. Thus knowing the desired value for brake cylinder pressure corresponding to a given brake pipe pressures, the software in the microprocessor **40** can determine whether the appropriate response has been produced. This can be determined by measuring the brake pipe pressure and the brake cylinder pressure over time. Also the value of the reservoir **22** may be measured and used an addition in direction of the brake valve BV's response.

Not only can there be made a determination of whether the brake cylinders has the appropriate end value, but there can also be a measure of how long it took the brake cylinder pressure to be reached after the brake pipe pressure has stabilized. The algorithms profile will also determine if for a sufficient increase of the break pipe pressure that the brake cylinder should be released. If after a brake pipe release pressure is produced the brake cylinder still has a pneumatic pressure, this would indicate a stuck brake. Providing the two brake cylinder transducers BCT**1** and BCT**2**, the operability of the empty load device **26** may also be monitored.

The transducer input data is compiled and compared to the baseline performance characteristics to determine the status or state of the brake system and determine what diagnostic message is appropriate. These states may include 1) good, 2) performance degradation noted, advise at next scheduled or unscheduled maintenance, 3) performance degradation noted, advise at destination, or 4) failure noted, proceed to next available repair point, or stop train immediately. The information is then coupled with the GPS time, speed and location stamp. Once an event occurs, the onboard processor **40** will retain data from the pressure transducers, accelerometer and GPS inputs for some determined time period at least prior to the event. A moving window of data is stored in the processor **40** and allows preparing a report with data prior to and after an event. At this time, an exception message and/or data related to the out-of-norm event can be automatically sent as a report via wireless communication **46** (for example a cell phone) to various pre-determined addresses. Information can be entered into work order system and/or closed looped back to the loco-

motive. The information from the accelerometer **49** is indicia of ride quality at time of failure.

Although the present invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation. The spirit and scope of the present invention are to be limited only by the terms of the appended claims.

What is claimed is:

1. A train brake diagnostic system, comprising:

a plurality of transducers for outputting status data of a single rail car, wherein said plurality of transducers include a brake pipe transducer connected to a brake pipe of the single rail car and at least a first brake cylinder transducer connected to an input of an empty load device of the single rail car and a second brake cylinder transducer connected to an output of the empty load device of the single rail car;

an accelerometer providing movement data of the single rail car;

a global positioning system providing time and location data of the single rail car;

a processor interconnected to the plurality of transducers, wherein said processor is programmed to receive and store the status data received from the plurality of transducers, the accelerometer, and the global position system over a predetermined period of time, to compare the data received from the plurality of transducers against a predetermined performance standard, to determine whether a fault has occurred in the single rail car based on the comparison, and to prepare an electronic report if a fault has occurred that includes the status data received from the plurality of transducers as well as the movement data received from the accelerometer and the time and location data received from the global positioning system for a predetermined time period prior to the fault.

2. The system of claim **1**, wherein said plurality of transducers further comprises an auxiliary reservoir transducer.

3. The system of claim **2**, wherein said plurality of transducers further comprises an emergency reservoir transducer.

4. The system of claim **1**, wherein the fault is selected from the group consisting of a brake valve failure, a stuck brake, a slow to apply brake, a slow to release brake, a slow reservoir charge, an empty/Load valve failure, and combinations thereof.

5. The system of claim **1**, wherein said electronic report includes a diagnostic message appropriate to the fault.

6. The system of claim **5**, wherein said diagnostic message indicates that maintenance is needed.

7. The system of claim **5**, wherein said diagnostic message indicates that the train should be stopped immediately.

8. The system of claim **1**, further comprising a wireless transmitter interconnected to said processor, wherein said processor is further programmed to wirelessly transmit said report using said wireless transmitter.

* * * * *